STATEMENT OF WORK :
UHV deposition stage with heater and rotation

Background

The cryogenic detectors fabrication program requires upgrades to its superconducting bilayer deposition tool known as the GSFC APX system. The goal of these upgrades is to improve film uniformity by introducing a temperature-controlled, rotating deposition stage for 4" wafers that is compatible with the current UHV deposition tool. The purpose of the UHV deposition tool is to deposit metal films on 4" substrates with specific properties via electron beam or epitaxial deposition to fill specific critical functions in detector systems. The uses of the films range from high conductivity device layers to tunable superconducting detector layers. The upgrades will improve reproducibility of the deposited films by better maintaining the substrate temperature during the deposition and introducing substrate rotation to promote film thickness uniformity.

Objectives

The objective is to build and install a deposition stage for 4" wafer in GSFC's APX electron beam deposition system. The term APX refers to the original manufacturer of the electron beam deposition system that is being upgraded with the new capabilities provided by the stage. The stage will be UHV compatible and meet specifications for heating and rotation of the substrate during deposition. The stage will be compatible with the existing wafer loading system employed by the APX system.

The job will require designing and building a functional stage, verifying that the upgraded stage is compatible with the existing system, on-site acceptance of the stage installed in the APX system, and manuals in electronic and paper form for training of personnel in its care and use.

Scope

This SOW applies to the procurement of a 4" wafer stage, which interfaces directly and seamlessly with existing NASA hardware. Specifically the contractor shall provide all hardware, system component design, and operation manuals and instructions pertaining to the wafer stage and its function. The scope does not apply to laboratory infrastructure to enable the upgrades, such as utilities installation (electrical power, compressed gasses).

Tasks or Requirements

Wafer Stage General Description: The stage will be designed for 100 mm wafers in an ultra-high vacuum system. The stage will meet requirements for rotation and wafer heating, maintaining an acceptable chamber pressure and system cleanliness (especially fine particulates) during operation. The stage will have a mechanical fixture and raising and lowering capability which can receive substrates from the existing substrate load/unload mechanism on the GSFC APX system. The installation to be provided by the vendor includes all connections, cabling, and gauges needed to implement the stage.

This installation assumes that GSFC supplies the electrical power from a wall outlet and water cooling needs of the new deposition stage. GSFC has a 2 kW heater power supply which can be used to supply power to the heater on the new stage. The vendor can provide an option for providing the power supply instead of using the GSFC unit. The deposition stage mounting interface will be designed so that it can be removed from the system and the original wafer stage can be re-installed as needed (i.e. the original conflat flange cannot be modified and its specifications will be provided to the vendor).

Electrical interfaces: the contractor shall provide all other cables and power supplies and motors for the stage to control its vertical and rotational motions. These motor //power supply combinations can be listed as options if the vendor prefers.

Mechanical interfaces: The complete deposition stage will be mounted to a 10" CF flange port at the top of the existing APX uhv chamber.

Wafer heating:

The heater element - preferably a pyrolitic Graphite coated Graphite (PgG) element- shall have a robust, reliable, and high temperature capability up to 1000 C and shall furthermore yield an excellent uniformity of better than +/- 3% across the central 90% of a 100 mm wafer which is placed 20 mm (+/- 2 mm) below the heater element. Substrate temperature of 700 C should be demonstrable with the 2kW of power provided by the GSFC power supply, or by the vendor's power supply (option) respectively. Thus, the effective range in wafer temperature shall be room temperature to 700 C.

The wafer rotations shall be smooth and continuous using a DC motor driven assembly. The rotational speed shall be manually adjustable from zero to at least 20 rpm. Its operation shall be highly reliable and shall have no significant impact (after initial outgassing) on the vacuum quality of the chamber during substrate rotation.

Wafer raising and lowering: The total linear travel of the stage shall be 100mm. The stage shall allow the loading of a wafer onto the stage (i.e. wafer cradle) at the loading level located 19 cm below the top flange of the chamber. From that level the stage shall be able to be linearly extended by 20mm and retracted by up to 80mm. The stage shall be motorized with a controlled DC motor assembly. A limit switch shall be used to operate the stage and set its position according to a scale bar (or ruler) mounted on the stage.

Wafer stage size / mass / footprint: The outer radius of the internal assembly of the stage shall be between 5.5 and 6.0 inches, and can not exceed this range. (This is due to the space limitations in our existing APX vacuum chamber and the requirements on the temperature uniformity. Drawings of the chamber space can be provided to the vendor if needed)

Wafer stage shall be fully uhv compatible.

We recommend Ferrofluidic or metal bellows feedthroughs for all mechanical motion.

All welded construction for compatibility with high temperatures (no hard or soft solder).

Gauges (Thermometry / Heater power / Stage height):
A temperature gauge for a temperature reading of up to 800 C (+/- 1%) shall be supplied and calibrated to measure the temperature of the wafer surface when mounted on the deposition stage. The temperature gauge shall not corrode, degrade or contaminate the system.

Option for an electrical readout of the power supplied to the heater gauge will be provided to monitor the required power as a function of wafer temperature (e.g., 2000 W +/- 20 W)

The stage height will be readout to mm-scale by a ruler affixed to the stage system.

For improving the wafer loading/unloading procedure, the current wafer orientation shall be monitored by an angular scale affixed the stage system (optional).

All gauges will be easily read by a user standing directly in front of the tool. GSFC will provide a panel on a nearby electronics rack

Wafer stage process compatibility:

Choose low outgassing materials and prebake all components prior to installation in APX system.

After the system has been vented, a straightforward procedure of heating the stage will be sufficient to re-achieve UHV conditions.

No production of magnetic particles internal to the UHV chamber through heating, rotation, raising lowering mechanisms, or wafer loading/unloading.

Other specifications:

Minimum 20 mm parallel gap between sample cradle and heater module as mounted relative to each other on the stage

Sample cradle -- In order to avoid metal contamination during wafer heating to 700 C the wafer cradle shall be made out of refractory metal, preferable molybdenum (purity equal or better than 99.99%).

Interlocks: An interlock will be provided to prevent operation of the system vent when the wafer chuck is hot or turning on of the wafer heater when the system is vented (not in the current quote I guess).

Installation and Training:

Vendor should demonstrate leak tightness of unit at their facility and then send it to GSFC for installation. Instructions for installation, use, care, and maintenance should

be provided and contract information for a technical representative to support the installation of the tool remotely.

Testing Specifications:
Chuck temperature: The system will demonstrate sufficient heating of the chuck such that its temperature achieves up to 700 C for an extended deposition in the chamber.

Process Chamber base pressure: With the upgrade hardware installed, a base pressure of less than 5e-9 torr will be achieved in the system (i.e., the new installation will not degrade the current base pressure of the system, which is achieved with bake out of the system). Such base pressure will me maintained during rotation and vertical raising and lowering operations. It is anticipated that using the heater element will cause chamber outgassing at pressure levels higher than 5e-9.

Selection Criteria

- The contractor shall have a proven track record of providing UHV-compatible equipment
- The contractor shall provide assurances to provide support of the installation through the demonstration of functionality of the system with the upgrades
- The vendor shall provide a minimum of two references for customers who obtained similar UHV-compatible equipment with rotary feedthroughs prior to award of contract.

Deliverables or Delivery Schedule

- The contractor shall provide the hardware for the 4" wafer chuck that interfaces directly to the existing APX deposition system
- Drawings for the system upgrades will be provided by the vendor to the technical representative at GSFC and require approval from the technical representative prior to moving to parts production. Drawings will be provided within two weeks of award by NASA and reviewed by the GSFC technical representative will be conducted with in two weeks of receipt of the drawings.
- The contractor shall receive 50% of the payment upon approval of the drawings and in advance of the production of parts. The remaining 50% will be awarded upon successful installation of the upgrades and demonstration of its functionality.
- The contractor shall provide all necessary cabling, hardware and safety interlocks for installation in the existing APX system.
- The contractor shall demonstrate the functionality of the unit and leak tightness and rotational operation without degrading the base pressure of the APX vacuum chamber.
- The contractor shall also provide training manuals and installation support (written instructions and telephone support).
- The contractor shall deliver the above items within 10 weeks from the date of the approval of drawings at NASA/GSFC and provide the specified services in support of the installation at NASA/GSFC

- The contractor shall provide two copies of documentation, (one printed on cleanroom paper and one electronic).

Government-Furnished Equipment and Government-Furnished Information

- The government will furnish (GFE) access to its APX system and all drawings of the system for the purposes of its upgrading.
- The government will supply power, utilities, and pumps for the purposes of operating the upgraded system.
- Government-furnished information (GFI) NASA/GSFC Code 553 personnel have contacted all known suppliers of system upgrades and provided the specific equipment that the upgrade hardware must interface to.

Security

- No additional security requirements are necessary for the work to be done.

Place of Performance

- The wafer stage hardware and its supporting components will be assembled and initially evaluated at the contractor's facility.
- Any machining or other modifications to GSFC's APX system will occur on site at GSFC.
- Final system installation, demonstration of functionality of the upgrades in the APX system and acceptance testing by appropriate GSFC personnel will occur at the NASA/Goddard Space Flight Center.

Period of Performance

- Delivery of the system at GSFC shall be 10 weeks ARO
- Installation and acceptance shall occur at GSFC within one month of delivery of the system at NASA/GSFC.